

## THE BROWN LACEWING GENUS *NOTIOBIELLA* (NEUROPTERA: HEMEROBIIDAE) FROM DOMINICAN AMBER

JOHN D. OSWALD

Department of Entomology, Texas A&M University, College Station,  
Texas 77843-2475, E-mail: j-oswald@tamu.edu

*Abstract.*—*Notiobiella thaumasta*, new species, is described from four specimens preserved in Dominican amber. Probably of mid to early Miocene age, this species appears to be closely related to the extant *Notiobiella* species (particularly *israeli*) that currently occupy Cuba, Hispaniola and the adjacent Central and South American mainland. The specimens reported here are the first hemerobiids to be described in detail from New World amber and are the first reported fossils of the genus *Notiobiella*.

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The family Hemerobiidae, brown lacewings, is a cosmopolitan clade (Oswald, 1993) of approximately 550 species (Monserrat, 1990) of small predaceous lacewings belonging to the insect order Neuroptera. Oswald (1993) reviewed the existing literature on fossil hemerobiids, summarized available nomenclatural, taxonomic, and distributional data on fossil hemerobiid species, and compiled published records of fragmentary brown lacewing remains that are identifiable only to the rank of family or genus. Since that time, I have had the opportunity to examine several hemerobiid amber inclusions collected from the Dominican Republic on the Caribbean island of Hispaniola. The Dominican amber insect fauna now includes two described neuropteran species—*Porrerus dominicanus* Poinar and Stange (1996) [Myrmeleontidae] and *Notiobiella thaumasta*, new species [Hemerobiidae, described below]. Additional, undescribed, specimens belonging to the families Ascalaphidae and Chrysopidae (Grimaldi, pers. comm.), Coniopterygidae (Poinar, 1992), Hemerobiidae (a hemerobiine apparently near *Hemerobius* or *Wesmaelius*, specimen in the Poinar Amber Collection; see Poinar, 1992:129, fig. 71) and Mantispidae (Grimaldi, 1996) are also known to exist. The hemerobiid specimens are of special interest as they are the only amber hemerobiids known from outside of the Baltic amber fauna. Together with the British Columbian rock-fossil *Bothromicromus lachlani* Scudder, these specimens constitute the only hemerobiid fossils known from the New World. The purpose of the present paper is to describe the several specimens that collectively constitute the first known fossils of the genus *Notiobiella*, and to place them within the context of our current knowledge of the extant fauna of this genus. For recent reviews of amber origins, sources, stratigraphy, ages and faunas see Anderson and Crelling (1995), Grimaldi (1996), Iturralde-Vinent and MacPhee (1996) and Poinar (1992).

### GENUS *NOTIOBIELLA* BANKS

*Notiobiella* Banks, 1909:80 (Type species [extant]: *Notiobiella unita* Banks, 1909; Australia): Alayo 1968 (review [as *Symphorobius*], Cuba); Monserrat and Penny 1983 (review, some tropical American species); Penny and Monserrat [1985] (re-

view, some tropical American species); Monserrat 1984a (review, some tropical American species); Monserrat 1984b (review, some African species); New 1988 (revision, Australia); New [1989] (review, New Guinea); Gonzalez Olazo 1992 (synonymy, neotropics); Oswald 1993 (phylogenetic position of genus).

**Diagnosis.** *Notiobiella* can be distinguished from all other extant hemerobiid genera by the following combination of forewing traits (after Oswald, 1993): (1) anterior radial trace bearing 2 prestigmal "radial sectors," (2) CuP forked proximal to crossvein 2cua-cup, and (3) prestigmal subcostal space no wider than adjacent subcostal vein [except at extreme base, adjacent to crossvein 1sc-r, where it is often somewhat wider]. Males are also characterized by an eversible, tubular, genitalic structure located between the gonarcus and parabaculum—the phallogingua—which is often strongly ornamented on its external surface when everted (Monserrat, 1984a; Monserrat and Penny, 1983). This structure probably functions as a holdfast organ during male/female coupling.

**Diversity and Geographic Distribution.** The 41 known, valid, extant species of the genus *Notiobiella* are collectively pantropical in distribution, being widely distributed in Central and South America (8 species), Africa (15; including Madagascar and the Seychelles), southeastern Asia (10; including Sri Lanka), Australia/New Guinea (7), and southwestern Pacific islands (1). Extant New World species range from southern Mexico south to Paraguay (6 continental spp.: *brasiliensis*, *cixiiformis*, *maculata*, *mexicana*, *paddiae*, *spinosa*), with two additional species known from the islands of Cuba (*israeli* and *pinarensis*) and Hispaniola (*israeli*). Apart from the few records of *israeli* and *pinarensis* reported by Alayo (1968) and Monserrat (1984a, 1998) from Cuba and Hispaniola, no other previously published records of *Notiobiella* species appear to exist for the islands of the West Indies. No Greater Antillean records for *Notiobiella* are contained in Smith (1931) or Wolcott (1927) for Hispaniola, Wolcott (1923, [1950]) or Leonard (1933) for Puerto Rico, or Jamaica, nor for any of the islands of the Lesser Antilles.

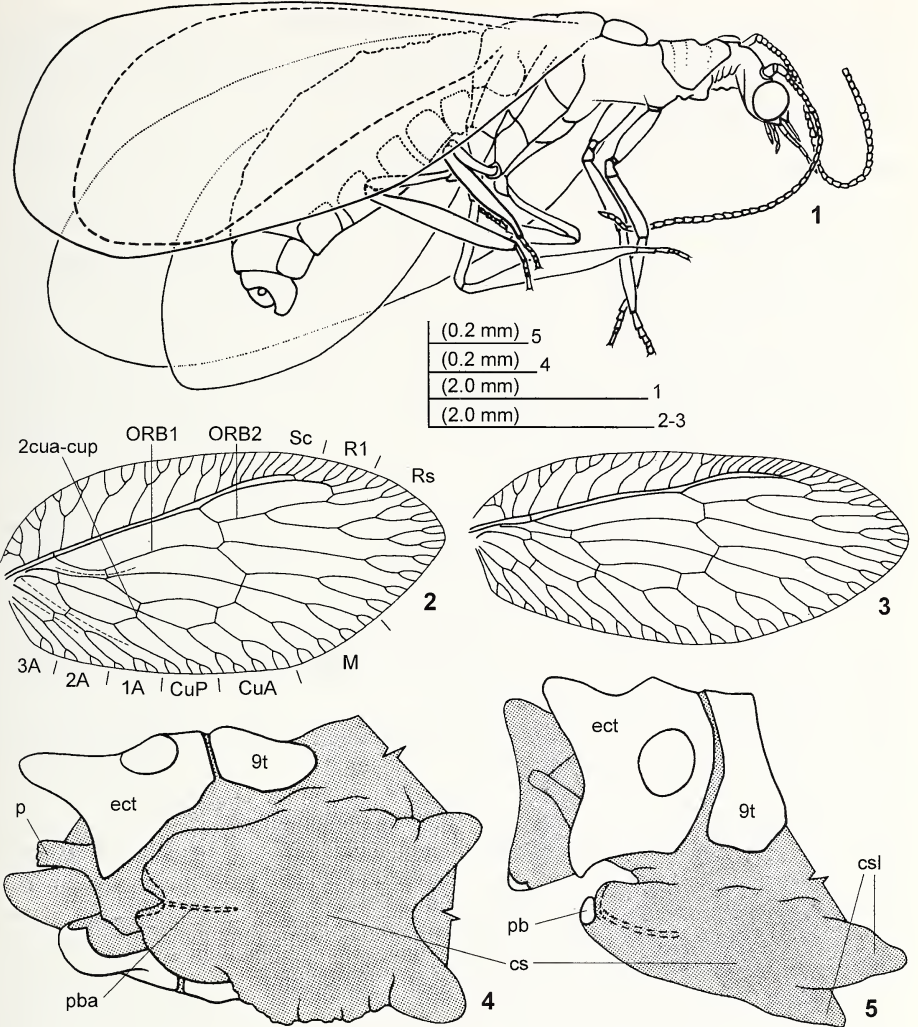
**Temporal Distribution.** Now documented from Recent to Miocene times. However, the broad pantropical distribution of this genus and the presence of endemic suites of species in the disjunct regions of Africa, Australia, Southeastern Asia and the New World suggest that the biogeographic distribution of this clade may have been influenced by the breakup of Gondwana. If this is true, the *Notiobiella* clade is probably of at least Cretaceous age.

**Discussion.** The specimens described below are the first known fossils of the genus *Notiobiella*.

### *Notiobiella thaumasta*, new species

Figs. 1–5

**Description.** Body coloration generally reddish-brown. *Forewing.* Length from base of tegula to wing apex 3.6–5.3 mm ( $x = 4.4$ ;  $N = 4$  wings). Venation as in Figs. 2–3. Rather short and broad, weakly angled apically. Costal space wide in basal half, narrowed distally. Veins reddish-brown, membrane hyaline, but with a darker macula surrounding crossveins 2m-cu and 2cua-cup. Anterior humeral trace recurrent and pectinately branched. Proximal subcostal veinlets branched distally. Posterior subcostal trace and anterior radial trace closely parallel. Anterior radial trace bearing



Figs. 1–5. *Notiobiella thaumasta*. 1. Female, approximately lateral view, AMNH DR-SH-18, wing venation omitted, 2. Forewing, dorsal, ♀, AMNH DR-14-1124 (right forewing), 3. Forewing, dorsal, ♂ holotype, AMNH DR-14-1124 (left forewing converted to standard right dorsal view); differences in forewing shape, especially width, between Figures 2 and 3 are distortion artifacts caused by different viewing angles and amber piece curvature), 4. Abdominal apex, ventrolateral, ♂ holotype, 5. Abdominal apex, posterolateral, ♂ holotype. Non-standard abbreviations: ect, ectoproct; ORB, oblique radial branch of radius; p, phallogingua; pb, parabaculum; pba, apophysis of parabaculum; cs, copulatory sac; csl, copulatory sac lobes.

two widely-separated, prestigmal, oblique radial branches (ORB's = "radial sectors"), the first basal, the second near mid-wing length. Basalmost fork of proximal ORB lying near fork R1-ORB2. Fourth (distal) gradate series absent. CuP forked proximal to crossvein 2cua-cup.

*Male terminalia.* Tergite 9: not divided sagittally. Sternite 9: a small transverse plate. Ectoproct: bilobed posteriorly; dorsal lobe prominent, apex with a moderately dense setal aggregation; ventral lobe somewhat more slender than dorsal lobe, its apex incurved as a short spiniform process; callus cercus with trichobothria present. Gonarcus: largely hidden from view; but apex of mediuncus and phallogingua protruding from between ectoprocts. Parabaculum: terminal lobes small, apophysis short and rod-like. 9th gonocoxites: absent. Hypandrium Internum: not visible.

*Female terminalia.* Tergite 8: lateral ends enclosing spiracles of 8th somite. Tergite 9: not divided sagittally, expanded ventrally as in other hemerobiids. Ectoproct: subtriangular, without protruding processes; callus cercus and trichobothria present. 9th Gonocoxites: semicircular to D-shaped; stylus present. Gonapophysis Posterioris: present (visible in AMNH DR-14-1124 ♀). Subgenitale: present (visible in AMNH DR-14-1124 ♂). Insemination/fertilization Canal: not visible.

**Types.** Holotype ♂, AMNH DR-14-1124 (♀ paratype in same piece), condition: apices of antennae polished away, otherwise complete. Paratypes (3 ♀ ♀): (1) AMNH DR-14-1124, 1 ♀ (♂ holotype in same piece), condition: head polished away except for apices of antennae and one palp fragment, dorsa of pro- and mesothoraces polished away, otherwise complete; (2) AMNH DR-14-1129, 1 ♀, condition: tip of left forewing polished away, otherwise complete; (3) AMNH DR-SH-18, 1 ♀, condition: tip of left antenna lost, otherwise complete.

**Geographic Distribution.** DOMINICAN REPUBLIC: Dominican amber, no further site or stratigraphic data available (all specimens).

**Temporal Distribution.** The fossils reported here probably date from the mid to early Miocene (see Iturralde-Vinent & MacPhee, 1996).

**Etymology.** Species-group name derived from Greek *thaumastos*, wonderful or marvelous.

**Discussion.** No question exists about the generic affinities of this species. The specimens are well preserved and each clearly exhibits several of the following synapomorphies of this genus identified by Oswald (1993): (1) mesolateral clypeal setae present [visible on one specimen], (2) prestigmal width of forewing subcostal space narrower than width of adjacent Sc [visible on all specimens], (3) forewing CuP forked proximal to crossvein 2cua-cup (Fig. 2) [visible on all specimens], and (4) phallogingua of male genitalia present (Fig. 4, p) [visible on the single male specimen]. Additional indicative, but not synapomorphic, characters include: (5) bases of ORB1 and ORB2 widely separated along anterior radial trace (Fig. 2), (6) ORB1 stem long, i.e., first forked near divergence of ORB2 from anterior radial trace (Fig. 2), and (7) male parabaculum with small terminal lobes and a baculiform apophysis (Figs. 4–5, pb, pba).

Extant *Notiobiella* species are rigorously diagnosable on the basis of characters of the male terminalia, particularly features of the ectoprocts, gonarcus/mediuncus complex and the phallogingua. The males of seven of the eight extant New World *Notiobiella* species are known (males of *pinarensis* are unknown). *Notiobiella thaumasta* can be distinguished from these species by the following male terminalic traits

(presentation format: contrasting species name—character: state in contrasting species (figure citation) [state in *thaumasta*): *cixiiformis* and *paddiae*—dorsal ectoproct lobe, lateral view: elongate, narrow, parallel sided (see Monserrat, 1984a:91, fig. 12 [*cixiiformis* as *rubrostigma*]; Monserrat, 1984a:95, fig. 33 [*paddiae*]) [short, broadly triangular, not parallel sided, Fig. 5]; *brasiliensis* and *maculata*—proximoventral corner of ectoproct, lateral view: narrowed, resulting in a narrow ventral ectoproct lobe (see Monserrat and Penny, 1983:128, fig. 7 [*brasiliensis*]; Penny and Monserrat, [1985]:886, fig. 11 [*maculata*]) [broad, ventral ectoproct lobe broad, Fig. 5]; *mexicana*—phallogingua, teeth of membrane: enlarged and prominent (see Monserrat, 1984a:87, figs. 4–5) [small and inconspicuous]; *spinosa*—ectoproct margin between apices of dorsal and ventral lobes, lateral view: slightly convex (see Monserrat and Penny, 1983:128, fig. 2) [distinctly concave, Fig. 5]; *israeli*—male parabaculum, terminal lobes, ventral view: divided distomedially by a rounded cleft and projecting anteriorly as a single, large, rounded lobe (Monserrat, 1984a:93, fig. 26) [divided distomedially by a V-shaped cleft and not projecting anteriorly as a large rounded lobe, Fig. 4].

Based on male terminalia traits, *thaumasta* appears to be more similar to *israeli* than to any other New World *Notiobiella* species. This close apparent relationship, together with the fact that *israeli* and *thaumasta* are both known from the island of Hispaniola, suggests that *thaumasta* may belong to the ancestral lineage of *israeli*—although this would be difficult to demonstrate conclusively.

The male and female specimens in amber piece AMNH DR-14-1124 appear to represent a formerly mated pair. This conclusion is supported by the close physical proximity of the two specimens in the piece, their opposite sexes, their entrapment in the same resin flow plane of the amber piece, and the exerted condition of the terminalia of the male. The terminalia of this male are particularly well preserved and deserve special comment. Nearly all of the external structures of the male terminalia are visible, as are some internal structures, where these are not obscured by overlying structures or the air bubble trapped within the abdomen. The most remarkable feature of this male specimen is the inflation of the membrane ventral to the 9th tergite and posterior to the 9th sternite to form a broad, flat-bottomed sac (Figs. 4–5, cs). The sac is terminated posteriorly by the terminal lobes of the parabaculum (pb)—the apophysis of which (pba) is clearly visible through the overlying membrane—and anteriorly by a pair of stout, bilaterally symmetrical, membranous lobes (csl). The entire structure is apparently an eversible sac that probably functioned as a copulatory device. Extant *Notiobiella* species should be examined for the presence of similar structures. Additional details of the male terminalia that are not normally observable in fossil hemerobiids include the narrow unornamented apex of the mediuncus and a more ventral tubular structure interpreted to be the partially exerted phallogingua.

Determination of the date of the fossils described here is complicated by: (1) the absence of precise geographical and stratigraphic information about them [e.g., mine or stratum data]; (2) the known existence of amber and “copal” deposits of widely varying ages from the Dominican Republic [Grimaldi 1995]; and (3) controversy surrounding the dating of the Dominican amber-bearing deposits [e.g., Lambert et al., 1985 vs. Iturralde-Vinent and MacPhee, 1996]. The mid to early Miocene date cited above is derived from the work of Iturralde-Vinent and MacPhee (1996), who

estimated this age for the sediments of the La Toca and Yanigua formations (which contain the main amber-producing mines northeast of Santiago) based on stratigraphic and taphonomic data. Earlier widely cited estimates of the age of ambers from this region based on nuclear magnetic resonance spectroscopy (Lambert et al., 1985; see Grimaldi, 1995 for a contrasting view) dated these ambers from the Upper Eocene.

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